

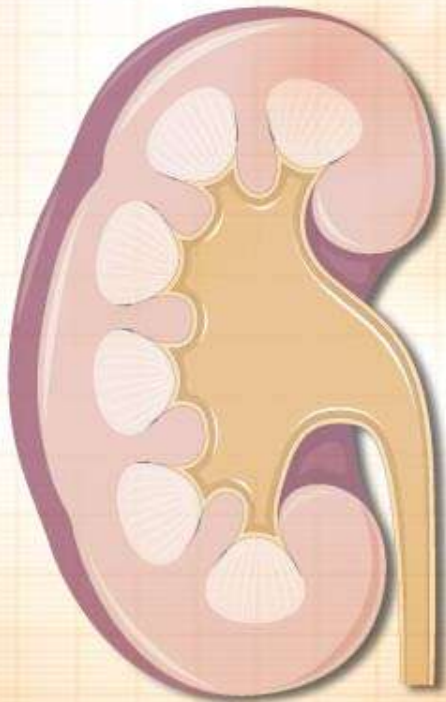
A vibrant, high-resolution photograph of a forest stream. The water flows rapidly over moss-covered rocks, creating white foam and splashes. The surrounding forest is dense with various shades of green, including ferns and moss on the rocks. The scene is peaceful and natural.

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Stigmata of fluid balance in patients with AKI

***By
Marwa Helmy Mansour***

Assistant lecture of Internal Medicine



AGENDA

☐ Principles of fluid management including:

- Therapeutic decision making.
- Choice of fluid solutions.
- Effect of fluid overload on outcomes.

☐ Practical issues to achieve fluid balance.

☐ Role of diuretics.

☐ KDIGO guidelines.

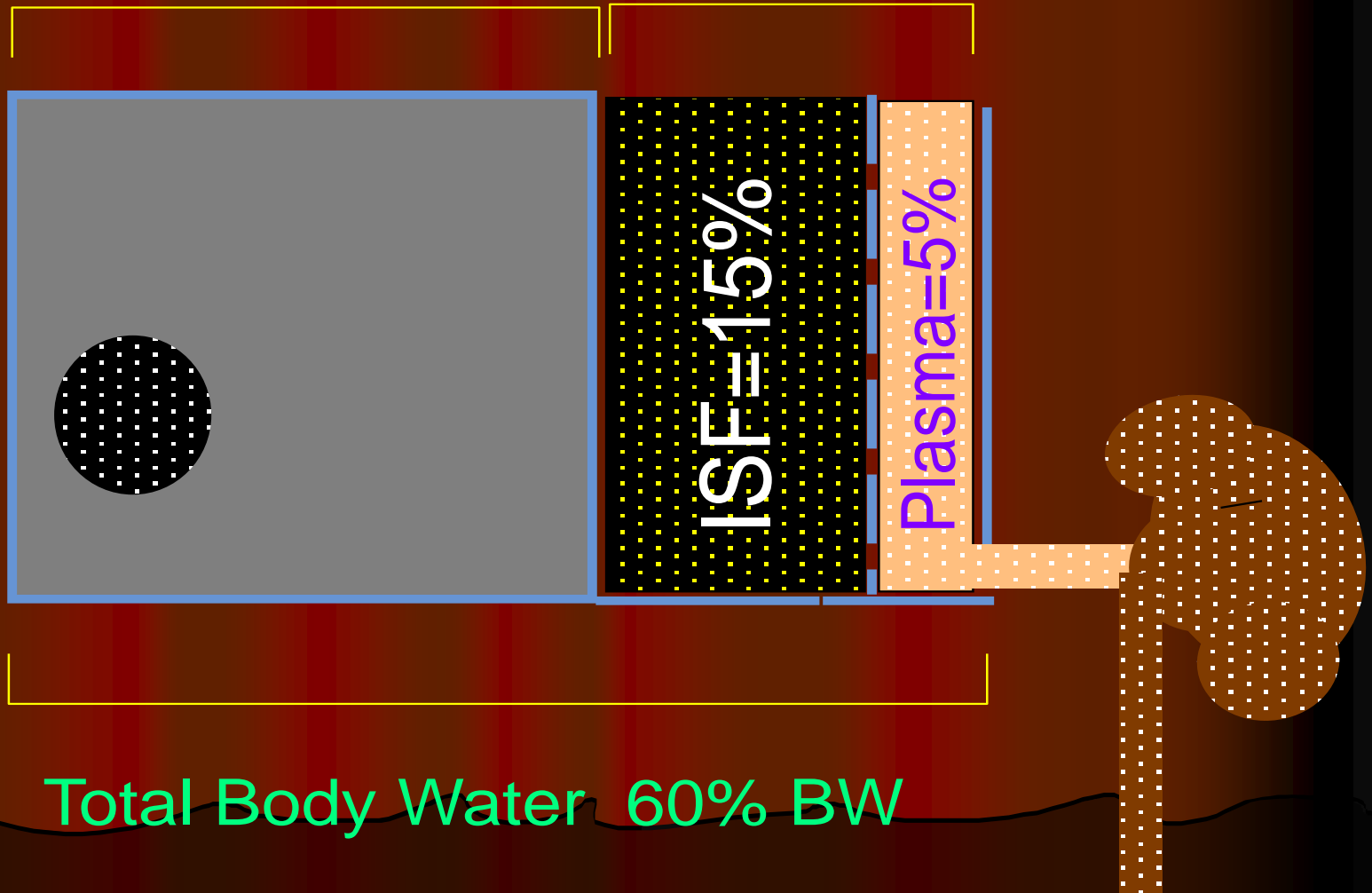
INTRODUCTION

- ❑ AKI is **a common pathology** in the intensive care unit (ICU) and postoperative settings.
- ❑ AKI is associated with **hemodynamic instability** requiring **fluid resuscitation** .
- ❑ Several studies have shown **that unbalanced fluid** leads to **adverse outcomes**, including (increased mortality and reduced renal recovery).
- ❑ Several questions regarding the role of fluid administration, including the **type, amount, duration** and its relation to **outcome**.

Assessment of Fluid Need

ICF= 40% BW

ECF= 20% BW



➤ Fluid administration contributes to **compartmental shifts:-**

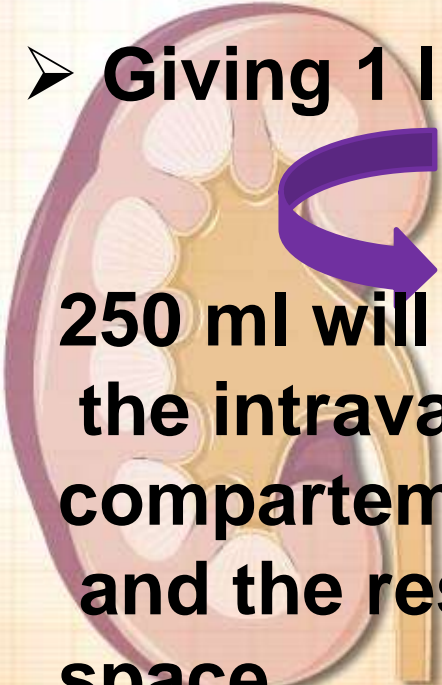
	% of Body Weight	% of Total Body Water	Volume (Litres)
ECF	27	45	19
Plasma	4.5	7.5	3.2
ISF	12.0	20.0	8.4
Dense CT water	4.5	7.5	3.2
Bone water	4.5	7.5	3.2
Transcellular	1.5	2.5	1.0
ICF	33	55	23
TBW	60%	100%	42 liters

➤ This compartmental shift is different according to the fluid infused.

❖ **Colloids** mostly remain in the intravascular space.

❖ **Crystalloids** distribute across compartments.

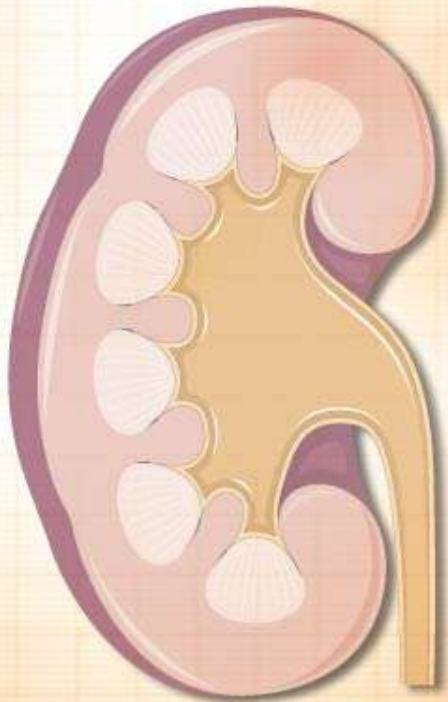
➤ Giving 1 liter of NaCl 0.9%,



250 ml will remain in the intravascular compartment and the rest will be into EV space.



*Is fluid really the best
medicine*

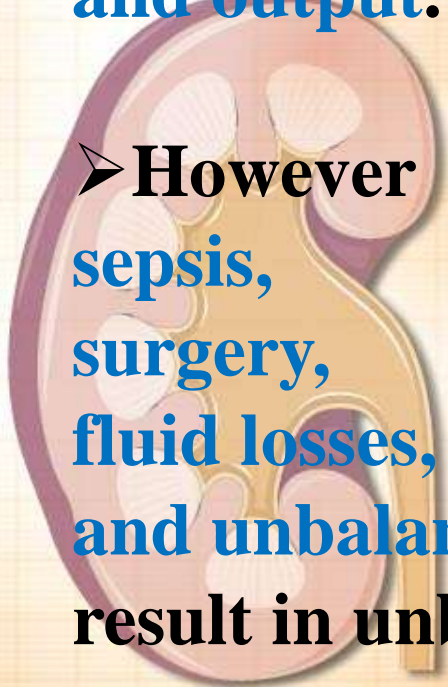


?

➤ The **principal** of fluid therapy is to restore effective intravascular volume to assure **adequate tissue perfusion**.

➤ Under normal conditions, water and electrolyte homeostasis is maintained through **balanced intake and output**.

➤ However different conditions such as **sepsis, surgery, fluid losses, and unbalanced fluid intake** result in unbalanced fluid distribution.



Therapeutic decision making

- There is a complex relationship of fluid accumulation and AKI.
- There is considerable variation in how fluid balance is recorded and calculated.
- ***Fluid chart:*** measuring input and output seem to be more accurate to quantify fluid balance (including insensible losses).

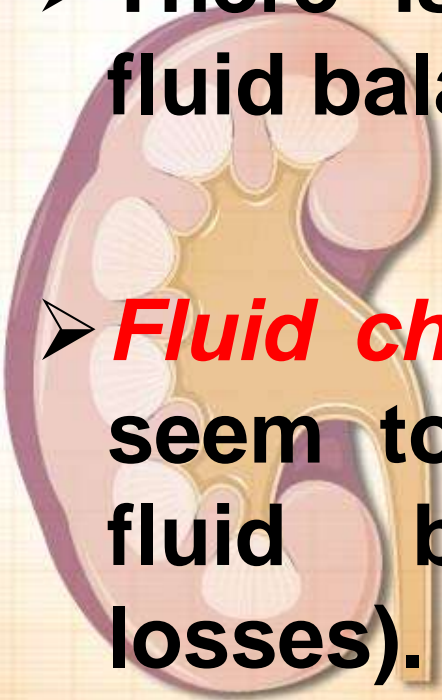


Table 1. Useful parameters for fluid status evaluation

Clinical parameters	Paraclinical parameters	Static measures	Dynamic measures
Body weight changes	Urinary indices (i.e. UNa, FeNa, FeUrea, specific gravity and osmolality)	Central venous pressure IVC diameter	Stroke volume variation and pulse pressure variation
Input/output balance	Hematologic changes	Pulmonary artery occlusion pressure	Aortic flow velocity and stroke volume
Blood pressure, heart rate and orthostasis	Bioelectrical impedance	RV end-diastolic volume	Positive pressure ventilation induced changes in IVC diameter
Urine volume	Lactates, SVO ₂	LV end-diastolic area	Microcirculation evaluation
Capillary refill, skin turgor	Extravascular lung water index	Intra-aortic blood volume index	
Organomegaly		Global end-diastolic volume index	
Pulmonary edema			

UNa = Urinary sodium; FeNa = fractional excretion of sodium; FeUrea = fractional excretion of urea; SVO₂ = venous saturation in oxygen; IVC = inferior vena cava; LV = left ventricular; RV = right ventricular.

Choice of Fluid and AKI

Colloids

- Synthetic hydroxyethyl starches(HES).
- Gelatins.
- Albumin.

Crystalloids

- Saline (NaCl 0.9, 0.45 or 3%).
- Lactate-based (Hartmann's solu).
- Balanced (Plasma-Lyte 148) solu.

ORIGINAL ARTICLE

Hydroxyethyl Starch 130/0.42 versus Ringer's Acetate in Severe Sepsis

Anders Perner, M.D., Ph.D., Nicolai Haase, M.D.,
Anne B. Guttormsen, M.D., Ph.D., Jyrki Tenhunen, M.D., Ph.D.,
Gudmundur Klemenzson, M.D., Anders Åneman, M.D., Ph.D.,

Using HES showed a negative effect on survival and an increased need for RRT.

nejm.124 org july 12, 2012.

The CHEST trial compared HES versus 0.9% saline.

ORIGINAL ARTICLE

Hydroxyethyl Starch or Saline for Fluid Resuscitation in Intensive Care

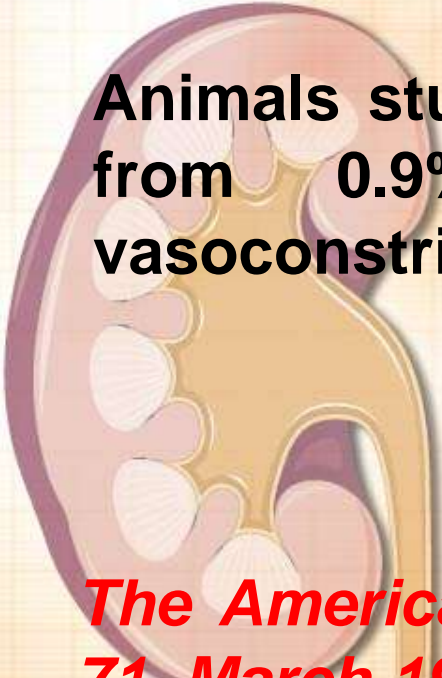
John A. Myburgh, M.D., Ph.D., Simon Finfer, M.D., Rinaldo Bellomo, M.D.,
Laurent Billot, M.Sc., Alan Cass, M.D., Ph.D., David Gattas, M.D.,
Parisa Glass, Ph.D., Jeffrey Lipman, M.D., Bette Liu, Ph.D., Colin McArthur, M.D.,
Shay McGuinness, M.D., Dorrielyn Rajbhandari, R.N., Colman B. Taylor, M.N.D.,
and Steven A.R. Webb, M.D., Ph.D., for the CHEST Investigators
and the Australian and New Zealand Intensive Care Society Clinical Trials Group*

Showed no significant mortality difference at 90 days .

nejm.org, november 15, 2012.

Regulation of Renal Blood Flow by Plasma Chloride

CHRISTOPHER S. WILCOX, *Department of Medicine and Clinical Pharmacology,
Harvard Medical School, The Brigham and Women's Hospital,
Boston, Massachusetts 02115*

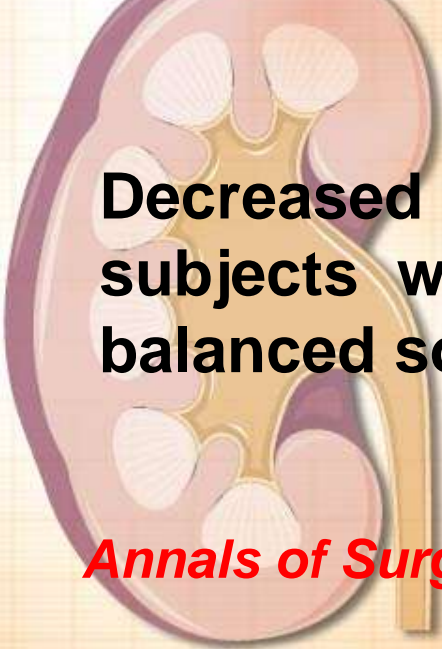
A stylized illustration of a kidney, showing the outer cortex and internal structures like the renal pelvis and papillae. It is positioned on the left side of the slide, partially overlapping the text.

Animals studies suggest that hyperchloremia resulting from 0.9% saline infusion causes arteriolar vasoconstriction and decreased GFR.

The American Society for Clinical Investigation, Volume 71, March 1983, 726-735.

A Randomized, Controlled, Double-Blind Crossover Study on the Effects of 2-L Infusions of 0.9% Saline and Plasma-Lyte[®] 148 on Renal Blood Flow Velocity and Renal Cortical Tissue Perfusion in Healthy Volunteers

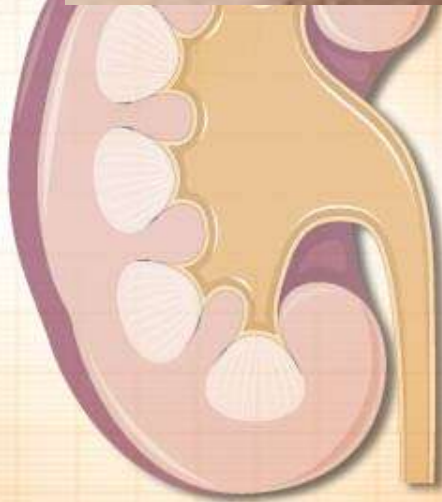
Abeed H. Chowdhury, BSc, MRCS, Eleanor F. Cox, PhD,† Susan T. Francis, PhD,†
and Dileep N. Lobo, DM, FRCS, FACS**



Decreased renal artery flow and cortical perfusion in subjects who received 0.9% saline compared to a balanced solution (Plasma-Lyte 148).

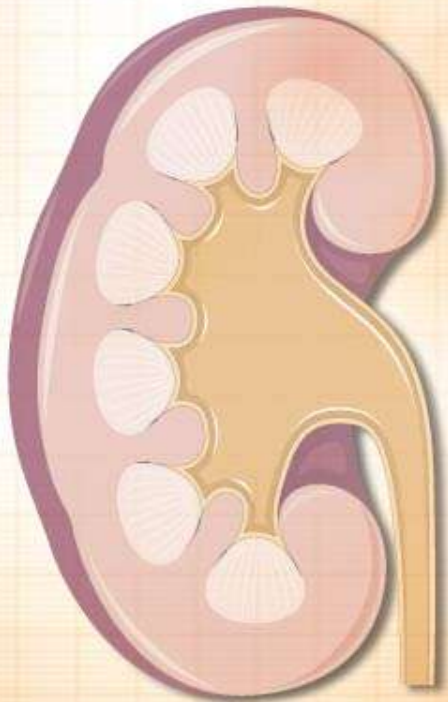
Annals of Surgery Volume 256, Number 1, July 2012

Patients

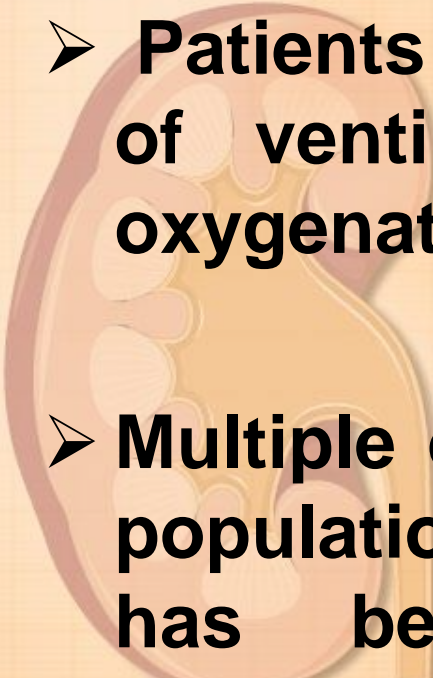




***What is the effect of fluid
overload (FO) on severity and
outcomes***



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- Defined as the **total input minus total output** divided by **initial body weight**.
 - It is associated with adverse outcomes when reaching **more than 10%**.
 - Patients with FO have an increased number of ventilation, ICU days and decreased oxygenation index.
 - Multiple observational studies from different populations (pediatric, sepsis, surgical), FO has been **associated with increased mortality**.

The SOAP study

A positive fluid balance is associated with a worse outcome in patients with acute renal failure

Didier Payen¹, Anne Cornélie de Pont², Yasser Sakr³, Claudia Spies⁴, Konrad Reinhart³, Jean Louis Vincent⁵ for the Sepsis Occurrence in Acutely Ill Patients (SOAP) Investigators

¹Department of Anesthesiology and Intensive Care, CHU Lariboisière, 2, rue Ambroise – Paré, F-75475 Paris Cedex 10, France

²Adult Intensive Care Unit C3-327, Academic Medical Center, University of Amsterdam, Meibergdreef 9, NL-1105 AZ Amsterdam, The Netherlands

³Department of Anesthesiology and Intensive Care, Friedrich-Schiller-University Jena, Erlanger Allee 101, D-07747 Jena, Germany

⁴Department of Anaesthesiology and Intensive Care, Charité-Universitätsmedizin Berlin, Hindenburgdamm 30, D-12200 Berlin, Germany

⁵Department of Intensive Care, Erasme Hospital, Université libre de Bruxelles, 808, Route de Lennik, B-1070-Brussels, Belgium

FO in septic patients with AKI was associated with a higher mortality at 60 days.

Critical Care Vol 12, No 3, 2008.

The PICARD group

Fluid balance and outcome in acute kidney injury: is fluid really the best medicine?

Raghavan Murugan, MD, MS, FRCP¹ and John A. Kellum, MD, FCCM¹

¹The Clinical Research, Investigation, and Systems Modeling of Acute Illness (CRISMA) Center, University of Pittsburgh School of Medicine, Pittsburgh, PA

The adjusted OR for mortality was 2.07 in patients with FO at initiation of RRT.

PICARD:- Program to Improve Care in Acute Renal Disease

Crit Care Med. 2012 June ; 40(6): 1970–1972.

The FACTT trial

Fluid Balance, Diuretic Use, and Mortality in Acute Kidney Injury

Morgan E. Grams,^{†} Michelle M. Estrella,^{*†} Josef Coresh,^{*†‡} Roy G. Brower,^{*} and Kathleen D. Liu[§] for the National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome Network*

Amongst patients who developed AKI within 2 days, positive fluid balance was associated with lower 60-day survival.

FACTT:- Fluid and Catheter Treatment Trial.

Clin J Am Soc Nephrol 6: 966–973, 2011.



Role of diuretics in AKI

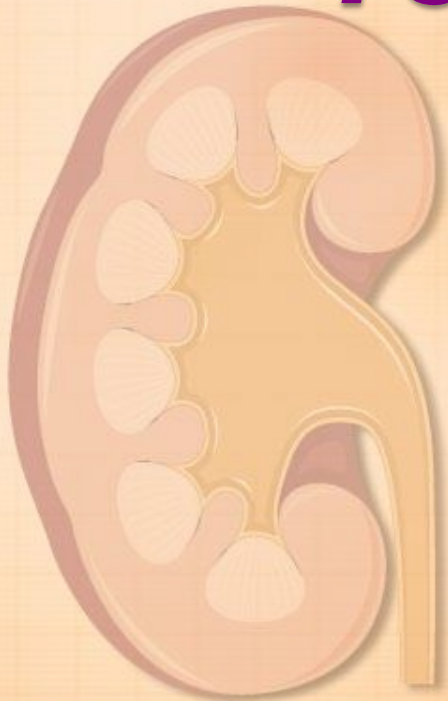
Most studies examining the effect of diuretics in AKI have found **no significant differences** on mortality or renal recovery.

Fluid Balance, Diuretic Use, and Mortality in Acute Kidney Injury

Morgan E. Grams,^{*†} Michelle M. Estrella,^{*} Josef Coresh,^{*†‡} Roy G. Brower,^{*} and Kathleen D. Liu[§] for the National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome Network

Clin J Am Soc Nephrol 16: 966–973, May, 2011

***What are the
recommendations***



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KDIGO guidelines

2.1.1 In the absence of haemorrhagic shock, we recommend using isotonic crystalloids rather than colloids (albumin or starches) as initial management for expansion of intravascular volume in patients at risk for AKI. (1B)



Nephrol Dial Transplant (2012) 0: 1–10

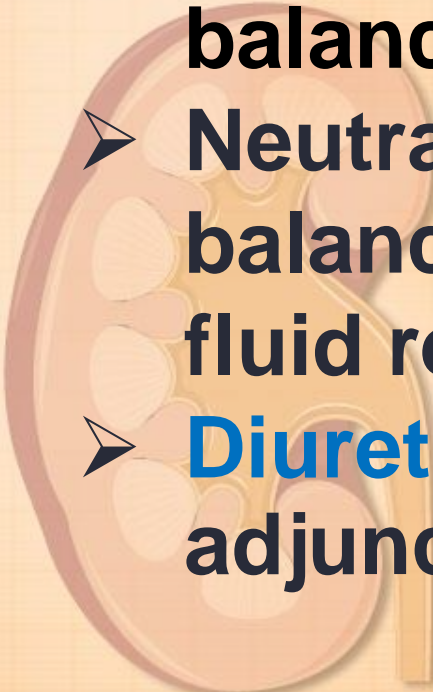
KDIGO guidelines

- 3.4.1: We recommend not using diuretics to prevent AKI. (1B)
- 3.4.2: We suggest not using diuretics to treat AKI, except in the management of volume overload. (2C)



Take Home Message

- **AKI is a common pathology** in the ICU.
- **Volume resuscitation** is a cornerstone in the treatment of hemodynamic instability.
- **Fluid balance** evaluation in the critically ill can be challenging.
- If **fluid therapy** is indicated (in true hypovolemia) **crystalloids** should be the preferred agents.

- 
- **Synthetic colloids** have been associated with **no** survival benefit in AKI.
 - FO may be **a marker of the severity** of AKI.
 - Correcting FO and restoring fluid balance are **important goals**.
 - Neutral and slightly **negative fluid** balance or **‘dry’** patients after initial fluid resuscitation are favored.
 - **Diuretics** should be used as adjunctive therapy in AKI **to treat FO**.



***Thank
You***